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Allen F. Bennett Head, Johnson & Kachigian 228 West 17th Place Tulsa, OK 74119				
EXAMINER ALEJANDRO, RAYMOND				
ART UNIT		PAPER NUMBER		
1745				

DATE MAILED: 03/02/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/821,505

Applicant(s)FOSTER, RONALD B. **Examiner**

Raymond Alejandro

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 07 January 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 37-54 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 37-54 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 03 August 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
- Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
- ☐ Certified copies of the priority documents have been received.
 - ☐ Certified copies of the priority documents have been received in Application No. _____.
 - ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|---|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____ |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Response to Amendment

This communication is responsive to the amendment filed 01/07/04. The applicant has overcome the objections and the 35 USC 112 rejections. However, the present claims are finally rejected as the 35 USC 103 rejections are herein maintained for the reasons of record.

Claim Objections

1. Claim 1 is objected to because of the following informalities: the following terms “Polymer”, “Electrolyte”, “Membrane”, “Electrode” and “Assembly” should not be capitalized as they don’t precisely mark the beginning of the claim sentence. Appropriate correction is required.

Specification

2. The amendment filed 01/07/04 is objected to under 35 U.S.C. 132 because it introduces new matter into the disclosure. 35 U.S.C. 132 states that no amendment shall introduce new matter into the disclosure of the invention. The added material which is not supported by the original disclosure is as follows: *the claim language “wherein the integrated circuit portion includes at least one active circuit component and at least one passive circuit component” is not supported by the original specification. It is noted that throughout the specification, applicant simply disclosed broad circuitry language, for example: “additional circuitry on a common substrate” (section 0001, 0011), “an integrated circuit operably coupled to the MEA” (section 0008), “a fuel cell control circuit and/or additional circuitry powered by the output of the MEA”*

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(section 0009). Accordingly, the foregoing claim language was not set forth in the original disclosure. Applicant is required to cancel the new matter in the reply to this Office Action.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

4. Claims 37-54 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the written description requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. The added material which is not supported by the original disclosure is as follows: (claim 37) *the claim language "wherein the integrated circuit portion includes at least one active circuit component and at least one passive circuit component" is not supported by the original specification. It is noted that throughout the specification, applicant simply disclosed broad circuitry language, for example: "additional circuitry on a common substrate" (section 0001, 0011), "an integrated circuit operably coupled to the MEA" (section 0008), "a fuel cell control circuit and/or additional circuitry powered by the output of the MEA" (section 0009). Accordingly, the foregoing claim language was not set forth in the original disclosure.*

Claim Rejections - 35 USC § 103

5. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

6. Claims 37-41, 43-50 and 53-54 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jankowski et al 2003/0138685 in view of Maynard et al 6541149.

The instant application is directed to an integrated circuit wherein the disclosed inventive concept comprises a fuel cell integrated to a substrate and a circuit. Other limitations include the integrated circuit; the fuel cell body; the substrate material; the polymer electrolyte material and its thickness; the catalyst material; the transition layer; and the water barrier.

As to claims 37-40:

Jankowski et al disclose a fuel cell integrated to a circuit wherein the fuel cell comprises a solid polymer or proton exchange membrane electrolyte, a porous substrate; a catalyst material, anode collector and a cathode collector and an integrated circuitry; and the driven device is a heater (ABSTRACT/ SECTIONS 0002, 0006, 0030 and 0035). It is also disclosed that electrodes (anode and cathode) have contact pads (SECTION 0030), that the anode electrode is a layer (SECTION 0029) and that the integrated circuit microfabrication process are used to pattern the electrode contacts (SECTION 0030). *Thus, the anode electrode contacts (the anode conductor) is a polygonal patterned structure as the layer configuration encompasses a planar structure having more than one angle and lines.* It is also disclosed that the electrical current generated

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from each cell is drawn away with an interconnect and support structure integrated with the gas manifold (SECTION 0026). *Hence, these interconnects also serve as the anode conductor.*

Jankowski et al teach full-integrated control circuitry along with integrated resistive heaters (SECTION 0006); the fuel cell also may contain a rechargeable micro-battery for start-up control, and utilized integrated resistive heaters, and may utilize integrated microvalves, resistive heaters or other means to control the flow of fuel to the fuel cell stack (SECTION 0016, 0044) as well as power transforming circuitry utilized to provide the appropriate output voltage and power (Section 0016, 0044). Thus, it is noted that, at least, either the associated circuitry of the micro-battery per se, or of the microvalves itself, or of the control means or of the power transforming circuitry act as the additional active circuit component powered or not powered by the output of the MEA.

(57)

ABSTRACT

A micro-electro-mechanical systems (MEMS) based thin-film fuel cells for electrical power applications. The MEMS-based fuel cell may be of a solid oxide type (SOFC), a solid polymer type (SPFC), or a proton exchange membrane type (PEMFC), and each fuel cell basically consists of an anode and a cathode separated by an electrolyte layer. The electrolyte layer can consist of either a solid oxide or solid polymer material, or proton exchange membrane electrolyte materials may be used. Additionally catalyst layers can also separate the electrodes (cathode and anode) from the electrolyte. Gas manifolds are utilized to transport the fuel and oxidant to each cell and provide a path for exhaust gases. The electrical current generated from each cell is drawn away with an interconnect and support structure integrated with the gas manifold. The fuel cells utilize integrated resistive heaters for efficient heating of the materials. By combining MEMS technology with thin-film deposition technology, thin-film fuel cells having microflow channels and full-integrated circuitry can be produced that will lower the operating temperature and will yield an order of magnitude greater power density than the currently known fuel cells.

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[0002] The present invention relates to fuel cells, particularly to small, compact fuel cells, and more particularly to a miniature power source composed of a stack of fuel cells fabricated by combining MEMS and thin film deposition technologies to produce fuel cells with microflow channels, fully-integrated control circuitry, and integrated resistive heaters.

[0030] As has been shown in FIG. 1, the incorporation of manifold structure within the host substrate through micro-machining techniques enables a complete fuel cell device to be realized which can be readily attached to fuel and oxidant sources. FIG. 3 illustrates an exploded view a complete fuel cell stack including the resistive heater, not shown in the FIGS. 1-2 embodiment. In the approach of FIG. 3, the fuel cell generally indicated at 40, includes a membrane-electrode assembly created by thin-film deposition techniques, or a combination of laminate, thin film and thick film assembly techniques and generally indicated at 41, and a micromachined substrate-manifold assembly or system generally indicated at 42. Integrated circuit type microfabrication processes are used to pattern the electrode contacts, as well as to form a resistive heater element within the fuel cell stack structure. The components of the membrane-electrode assembly 41 is subsequently formed into a free standing membrane by selective etching of openings or windows 43 in a substrate 44 on which the components are deposited as in the FIG. 2 embodiment, the substrate 44 being an upper component of the manifold assembly 42. In an alternative embodiment, the components of the membrane-electrode assembly 41 is subsequently formed on a porous thick film membrane or host structure which is positioned over the openings or windows 43 in a substrate 44 on which the components are formed, the substrate 44 being an upper component of the manifold assembly 42. Manifold channels are micromachined in another substrate 45, the lower components of the manifold assembly 42, which is subsequently bonded to the substrate 44. The membrane electrode assembly 41 includes an electrode (anode) 46 having a contact pad 47, a heater isolation member 48 having openings or window 49 which align with openings or windows 43 of substrate 44, a resistive heater 50 having contact pads 51 and 52 and constructed so as not to cover the openings 49 in member 48, an electrolyte 53, and an electrode (cathode) 54 having a contact pad 55. For example, the electrode/electrolyte/electrode (components 46, 53 and 54) may be composed of nickel (Ni)-yttria stabilized zirconia (YSZ)-silver (Ag), the resistive heater 50 composed of platinum, and the

heater isolation member 48 composed of silicon dioxide or other material which provides electrical isolation from the electrodes with openings 49 being 2 mmx2 mm, and with the substrates 44 and 45 composed preferably of silicon but may be composed of glass, ceramic, plastic, or other material having the qualities described above, with windows 43 being 2 mmx2 mm.

Figures 1, 5-6 and 8 illustrate the fuel cell configuration:

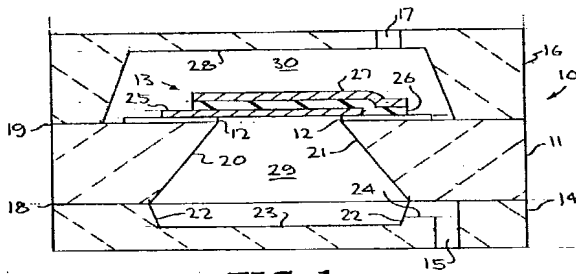


FIG. 1

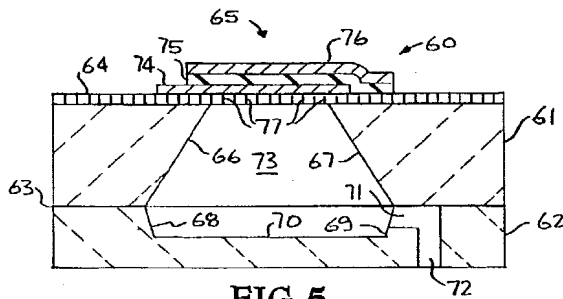


FIG.5

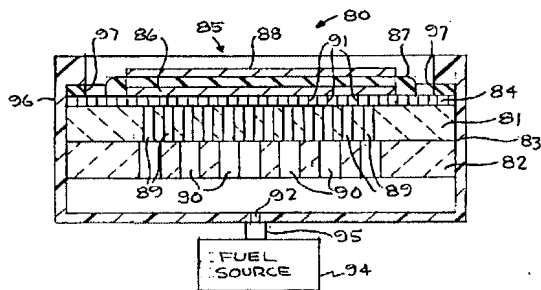


FIG. 6

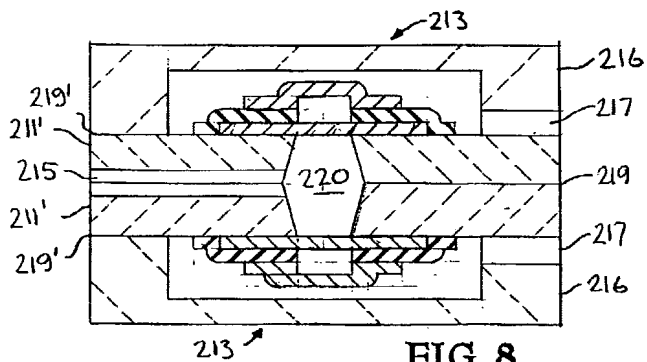


FIG. 8

As to claim 41:

It is disclosed that the substrate is made of silicon (Section 0028, 0029, 0036).

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the Si-based substrates

As to claims 44-45:

It is disclosed that the electrolyte is made from Nafion (SECTION 0038).

num with a thickness of 1000 Å to 2 microns; and the electrolyte/catalyst 75 being composed Ni/YSZ, Pt/Nafion, or Pt/C/Nafion with a thickness of 1 micron to 50 microns

As to claims 46-48:

It is disclosed that the electrolyte thickness is thinner than 1-2 μm (Section 0005 & 0045).

shorting through the electrolyte layer. This enables the electrolyte layer to be on the order of 1 μm thick rather than

rechargeable batteries as a miniature power source. Since the fuel cell electrolyte layer can be made thinner, e.g. 1-2 μm thick as compared to 1 mil, then the operating temperature

As to claims 49-50:

It is disclosed that the catalyst comprises at least Pt (SECTION 0038).

num with a thickness of 1000 Å to 2 microns; and the electrolyte/catalyst 75 being composed Ni/YSZ, Pt/Nafion, or Pt/C/Nafion with a thickness of 1 micron to 50 microns

As to claims 52 (see also rejection below of claim 52) and 53-54:

It is disclosed that additional layers of catalyst materials can also separate the electrode (cathode or anode) from the electrolyte (SECTION 0035). It is thus noted that the additional catalyst layers can also act as the transition layer for lowering the electrical resistance as well as the water barrier adjacent to the back surface catalyst material.

membrane electrolyte materials. Additional layers of catalyst materials can also separate the electrode (cathode or anode) from the electrolyte. In these embodiments micro-machined manifolds can be utilized to transport the fuel and oxidant, to each cell and provide a path for exhaust gases.

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Jankowski et al disclose a MEMS-based thin-film fuel cell according to the above-mentioned aspects. However, Jankowski et al do not disclose the specific gas-diffusion region; and the particular semiconductor substrate.

With respect to claim 37:

Maynard et al disclose a micro fuel cell formed by using a silicon substrates wherein the silicon substrate comprises a porous silicon gas diffusion regions 32, 63 or 85 (ABSTRACT/COL 3, lines 46-47/ COL 6, lines 19-20/ COL 6, lines 60-62).

With respect to claim 43:

It is disclosed that the substrate is made from SiN_x (COL 7, lines 50-52) or boron-doped silicon substrates (COL 8, lines 54-56).

In view of the above, it would have been obvious to one skilled in the art at the time the invention was made to make the fuel cell of Jankowski et al by having the specific gas-diffusion region of Maynard et al as Maynard et al teach that such gas diffusion regions allow gas to diffuse into the fuel cell. Thus, gas is able to diffuse through the porous diffusion layer region.

As to the particular semiconductor substrate, it would have been obvious to the skilled artisan to use the particular semiconductor substrate of Maynard et al as the substrate material of Jankowski et al as Maynard et al teach that semiconductor materials can be used as substrate because they have sufficient mechanical strength, can withstand the operating temperature of the fuel cell and can be micromachined or lithographic processed to form the desired fuel cell structure.

7. Claim 42 is rejected under 35 U.S.C. 103(a) as being unpatentable over Jankowski et al 2003/0138685 in view of Maynard et al 6541149 as applied to claim 37 above, and further in view of Gorer 6498121.

Jankowski et al and Maynard et al are applied, argued and incorporated herein for the reasons above. In addition, the preceding prior art does not disclose the substrate comprising sapphire.

Gorer teaches a fuel cell electrode embodiment wherein the independent electrodes were fabricated on inert substrates such as sapphire and thermally treated silicon (COL 8, lines 60-67).

Thus, it would have been obvious to one skilled in the art at the time the invention was made to use the substrate comprising sapphire of Gorer as the additional substrate material of both Jankowski et al and Maynard et al because Gorer discloses that the sapphire material can be used as an inert substrate wherein an array of independent fuel cell electrodes can be fabricated thereon. Thus, Gorer directly teaches that sapphire substrates are inert and suitable for fuel cell applications.

8. Claims 51-52 are rejected under 35 U.S.C. 103(a) as being unpatentable over Jankowski et al 2003/0138685 in view of Maynard et al 6541149 as applied to claim 37 above, and further in view of Lin 5750013.

Jankowski et al and Maynard et al are applied, argued and incorporated herein for the reasons above. In addition, the preceding prior art does not disclose the specific catalyst materials.

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Lin discloses that in the application to fuel cell, the catalyst material used is mainly Pt or the alloy of Pt with one or more metals such as Rh, or Pd as well as gold, nickel and Ir (COL 4, lines 15-25).

reactors, and sensors. For example, in the application to fuel cells, the metal used is mainly Pt or the alloy of Pt with one or more metals selected from the group consisting of gold, the metals of Group VB (such as V, Nb, Ta), the metals of Group VIII (such as Fe, Co, Ni, Ru, Rh, Pd, Os, Ir), the metals of Group VII B (such as Mn, Tc, Re), and the metals of Group VI B (such as Cr, Mo, W) of the periodic table. In

In view of the above, it would have been obvious to one skilled in the art at the time the invention was made to use the specific catalyst materials of Lin in the fuel cell of both Jankowski et al and Maynard et al as Lin teaches these catalyst materials are suitable for fuel cell applications because they are active catalytic materials which are chemically compatible with the fuel cell chemical reactions, the reactants and the electrode materials employed in the fuel cell. Thus, these catalyst materials are chemically compatible with the chemistry and reacting environment of the fuel cell.

Response to Arguments

Applicant's arguments filed 01/07/04 have been fully considered but they are not persuasive. The primary contention of applicant's arguments is premised on the assertion that the prior art of record failed to disclose "*the anode conductor being patterned to be porous*" or "*a porous thin-film anode conductor*". In this regard, it is noted the language of independent claim 37 is silent to this limitation. That is to say, the foregoing claim simply recites "the anode conductor patterned in a polygonal array". Accordingly, as indicated above, since the prior art teaches thin-film fuel cell comprising electrodes (anode and cathode) having contact pads,

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wherein the anode electrode is a layer and wherein the integrated circuit microfabrication process is used to pattern the electrode contacts, *thus, the anode structure of the applied art clearly satisfies the contended requirement of being patterned in a polygonal array because the anode electrode contact layer configuration (the anode conductor) encompasses a planar structure having more than one angle and lines.*

As to the assertion that this anode conductor allows for low resistance while still allowing rapid diffusion, it is noted that the prior art teaches the electrode/catalyst/electrolyte structure enables the fuel cell to produce continuous electric current (SECTION 0026) as well as having a catalyst and electrolyte interface that optimize performance by reducing resistive losses therealong (SECTION 0028) and wherein the requirements of the electrodes are that they have low resistance, continuous conductivity, and are porous enough for the fuel and byproduct to diffuse therethrough (SECTION 0041). In view of that, those of ordinary skill in the art would recognize that the anode conductor of the prior art provides substantially the same low resistance and the diffusion as the anode conductor of the instant claims. Furthermore, the instant claims fail to recite any degree of resistance and/or diffusivity so as to positively setting forth that, in fact, this anode conductor is able to provide such functions. Moreover, it is further noted that the substrate-film configuration of the prior art is substantially the same as the claimed substrate-film configuration, and, consequently, it is able to provide the necessary functional and structural interrelationship to meets the foregoing requisite.

In response to applicant's argument that the references fail to show certain features of applicant's invention, it is noted that the features upon which applicant relies (i.e., "a conductive substrate") are not recited in the rejected claim(s). Although the claims are interpreted in light of

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the specification, limitations from the specification are not read into the claims. See *In re Van Geuns*, 988 F.2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993). *Nevertheless, it is contended that the electrical nature of the prior art's substrate is conductive as it enables the conduction of electrical power out of the fuel cell stack.*

With respect to the active and passive circuit components, the examiner contends that the applied references teach full-integrated control circuitry along with integrated resistive heaters (SECTION 0006); the fuel cell also containing a rechargeable micro-battery for start-up control, and optionally utilizing integrated resistive heaters, and utilizing integrated microvalves, resistive heaters or other means to control the flow of fuel to the fuel cell stack (SECTION 0016, 0044) as well as power transforming circuitry utilized to provide the appropriate output voltage and power (Section 0016, 0044). *Thus, it is noted that, at least, either the associated circuitry: of the micro-battery per se, or of the microvalves itself, or of the control means or of the power transforming circuitry act as additional active/passive circuit components powered or not powered by the output of the MEA. This is further applicable because some of above-mentioned electrical features will also function as an active circuit component or as a passive circuit component depending on the current operational mode (i.e. start-up mode, stand-by mode, fully operational mode or shut-down mode) of the fuel cell and its ancillary equipment.*

In response to applicant's argument that "*incorporation of such a passive device is a relatively simple matter. It simply requires the addition of a thin-layer of poorly conductive material*" or "*the device contemplates being operated at high temperatures*", the fact that applicant has recognized another advantage/disadvantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the

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differences would otherwise be obvious. See *Ex parte Obiaya*, 227 USPQ 58, 60 (Bd. Pat. App. & Inter. 1985). *It is also noted that the instant claims appear only to embody passive circuitry features because they are completely silent as to the necessity of high conductive material per se, and therefore, the intended scope of the invention simply embraces the use of passive devices for functional purposes.*

Conclusion

9. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Raymond Alejandro whose telephone number is (571) 272-1282. The examiner can normally be reached on Monday-Thursday (8:00 am - 6:30 pm).

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If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Patrick J. Ryan can be reached on (571) 272-1292. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Raymond Alejandro
Examiner
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A handwritten signature in black ink, appearing to read 'Raymond', with a long horizontal line extending to the right.